The Illinois Chemistry Teacher

A Journal

The Illinois Association of Chemistry Teachers

Volume 1 MAY, 1934 Number 2

The Chemistry Teacher's Contribution to Modern Culture*

By Otto Reinmuth

Editor, Journal of Chemical Education

You percieve that I have submitted to your chairman a topic which represents a special segment of the general subject, "The Place of Science in a Liberal Education." I am amazed at my own temerity in attempting the discussion of a subject which might well challenge the best efforts of a Tyndall or a Huxley, and which has, indeed, engaged the attention of both. Yet my intentions are, after all, very modest. Throughout the nine years of my association with the Journal of Chemical Education, I have constantly been faced with the necessity of attempting to translate some of the classical and pedagogical generalities into the specific terms of everyday classroom situations. I must confess that the benefit I derive from Huxley's address on "A Liberal Education" might more properly be inspirational than instructive. It makes, for instances, only the most indirect suggestions as to how I might go about presenting the theory of ionization to a class of high-school students. What I have to say this afternoon will therefore take the form of a number of tentative and perhaps more or less disconnected answers to such everyday questions.

I shall not attempt, save by implication, to define either culture or education. It seems worth while to remark in passing, however, that our cultural objectives should be strictly realistic, and should take due account of the possibilities. Culture at the high-school level must necessarily mean to us something less ambitious and less complete than the term in its broadest adult sense.

There are, however, certain aspects of culture which are common to all stages of its evolution. This becomes evident if we adopt one tenable point of view, namely: that culture is essentially an attitude of mind. This furnishes an incomplete picture only, for you will doubtless agree with me that culture must have extent as well as direction. I believe, however, that when direction is accepted as the primary consideration, we can confidently rely upon the time element in the matter of extent.

Granted this point of departure, the attitude and method of science asume far greater significance than the factual content. It seems to me that the best introduction to any course in science would be an examination of the true aims of science and a simple explanation of the scientific method of attack upon a problem. If the teacher hesitates to present the necessary discussion in his own words, he can well fall back upon class

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* Abstract of a talk delivered before the Illinois Association of Chemistry Teachers at Knox College, Galesburg, Illinois, March 3, 1934

THE
ILLINOIS CHEMISTRY TEACHER
A Journal of
THE ILLINOIS STATE ASSOCIATION OF CHEMISTRY TEACHERS
Normal, Illinois

Subscription rates—Twenty-five cents per year (three issues) for those who are not members of the Illinois Association of Chemistry Teachers.

Active members of the Association receive the Journal free.

Papers for publication—So far as space permits, papers for publication will be considered. Precedence will be given to papers given before the Illinois Association of Chemistry Teachers and the Illinois State Academy of Science.

The work of L. T. Lucas of J. Sterling Morton High School, Cicero, in attempting the unit method of teaching chemistry is being presented through this Journal in some detail for two reasons. First, it focuses our attention on objectives as a means of directing our teaching and as a guide in selecting teaching material. Second, it presents for our consideration a method of teaching that is now being advocated by many leading educators in colleges and universities and one that is now gaining considerable support in science teaching.

The setting up of definite goals in teaching toward which every effort is bent is undoubtedly economy of time and energy. It insures against wasted effort along a drifting course which the present organization of many of our text books tend to encourage. The choosing of the objectives is of prime importance and should be given careful consideration by every teacher. Furthermore the choice of objectives as well as the means of attaining them should be open to revision as the need for change is seen.

As machinery continues to displace more and more labor there will be an increasing need for education to fit one to use his leisure time with greater satisfaction. As Dr. Reinmuth points out in his article "The Chemistry Teacher's Contribution to Modern Culture," science has much to offer in this field. The question arises, what is now being offered and, more specifically, what does chemistry offer. Think over this question and send us a summary of the possibilities so that it may be brought to the attention of our teachers.

What does the diversion of a part of the gasoline tax of Illinois to help support the schools mean? For one thing it means that the schools are brought into active competition for revenue with the cities and hard road interests who are reluctant to share any of the fund. It means that if we are to continue to secure support from this fund we shall have to fight for it.

Organized Effort
vs
Lethargy

A slight tremor has preceded what may develop into an educational catastrophe. So slowly has the hand of fate grasped the unsuspecting structure of secondary education that the ever watchful pedagogical eye has scarcely discerned its motion. The tendency to grasp at the nearest support has done nothing for us; it has left us breathless in mid air. In the past decades we have been too busy with the enrichment and expansion of our curriculums to realize that there might be a time when even the long established subjects of the curriculum would be taken out of their security and questioned. Today we are faced with the possibility of having science, vocational education, and all of our great educational philosophy considered as frills. These subjects are being eliminated and even scoffed at by some of those who are hastily shaping the national budgets. They hope by such cutting to secure an ornament which will graciously adorn their political crowns and speak efficient economy to all who may gaze upon its splendor. In some sections of the state this has happened so suddenly that those most deeply concerned have had little opportunity to do more than gasp. This is a matter which concerns all of us, not next year, not next month, but today.

In the economic crises in our schools our teachers must find an opening sufficient to permit them to wedge their way into the attention of the public. If they do not find a solution which answers the needs of the time, the demands of the people, and the salvation of the school systems our educational institutions are due to find only destruction awaiting them. We shall have taught in vain.

Five years ago a speaker would have been considered daring, unethical, and probably fanatical had he asked that a group of teachers attempt to influence their state legislature, their congress, or any other group of lawmakers in this country. Today one cannot attend any group meeting of teachers without being urged to become an active citizen not only stating but demanding the rights of the schools. As teachers we are prone to bemoan our situation rather than to get out and act in behalf of what we know to be right and proper. We ask that Boards of Education justify our retention without realizing that the average member of the Board has much less education than has the average teacher. He is, if he is the right kind of member, interested in the schools, not supported by them.

It is our professional duty as teachers to show by word and deed that the communities can not afford to be without free secondary education. You may be startled by the fact that free secondary education should be questioned; but is has been and is now being questioned by many of our tax considering organizations. It may be considered even further if we as teachers do not actively show that free schools are far more to be desired than penal institutions. Have we as scientists the data necessary to prove that education costs less than hard roads? Have we reasons to justify spending tax money for education rather than construction? As the best educated group in our community are we asking that men make a stand for our schools before we give them our support, or are we, as we have done in the past, just sitting waiting for the garden variety of citizens to rise oratorically to our defense? It is with regret that we note that there are thousands of teachers actively engaged in the state of Illinois who are improperly fed and poorly clad while the government is giving sufficient aid to thousands who are less worthy. As a group we have not stood by our less fortunate members. There are many organizations, less powerful than ours need be, which have risen to the defense of their fellow worker, in sane and sensible ways, and have secured justice and support.

Whole hearted class room teaching is always the first qualification for a sucessful teacher, but in time of crises our patrons have a right to ask us to show leadership and courage. The men of indus-

try struggle to obtain what they consider their inalienable rights, and we as teachers cannot expect much assistance from them if we do not rise for our own cause and ask and keep asking for attention until we get it. The lawmakers of this state and nation are directly responsible to the people of the nation. In most cases they are giving their attention and support to those who fight the hardest for their rights. We have not received aid in many cases because we have failed to use our educational and legal rights to demand justice for the youth of our nation. The youth of today will make the world of tomorrow but their world will be much less than it should be if we stand by with folded hands and watch this educational destruction continue. The best qualified persons of our time have just awakened to the fact that their life dream is about to be destroyed. Will they say "Too bad," or will they say with righteous indignation "This cannot be?"

Every organization of teachers adds strength to our cause in so much as it helps its members to keep up courage to better themselves even in trying times. It would probably be timely for the members of the Illinois Association of Chemistry Teachers to work toward some goal of public appreciation of the contribution of Secondary Education as a whole and Chemistry as our part. We are not so well established that we can afford to rest on our oars. We shall either produce or be shoved into a much less desirable place in Secondary Eudaction than the place we now maintain.

Let us develop such stamina, such fortitude, and such ethical procedure that we may enter into non-partisan politics and have a hearing which will ensure our professional standing and make the average citizen well versed on school affairs and proud of the institutions which he is now questioning. We need leadership. Let ours be the organization to produce it.

Mable Spencer

Galesburg Meeting

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Minutes of Business Section

On March 3, 1934, the business session of the Illinois Association of Chemistry Teachers was held at Knox College, Galesburg, Ill. Mr. Glen Tilbury, president, presided at the meeting.

A group of members were interested in forming a circulating library, whereby they could have an opportunity to read some of the latest chemistry books. Signatures of twenty-four interested persons were obtained. A motion was made and seconded that the incoming president appoint a committee to make plans for the circulating library. The motion carried.

The election of officers was held, and the following persons were selected: President, Howard W. Adams, Professor of Chemistry, I. S. N. U., Normal, Ill.; Vice-President, Jared T. Lyon, Dwight Township High School, Dwight, Ill.; Secretary-treasurer, H. L. Slichenmyer, Bloomington High School, Bloomington, Ill. The retiring officers were: President Glen Tilbury, Urbana, Ill.; Vice-president, Howard W. Adams, Normal, Ill.; Secretary-treasurer, H. L. Slichenmyer, Bloomington,Ill.

A motion was made and seconded that the I. A. C. T. purchase a cup to be given to the high school having the best chemistry exhibit at the Illinois State Junior Academy of Science meeting to be held at Decatur, Ill., May 3, 1934. The motion carried.

A motion was also adopted that a committee be appointed by the president to notify the governor of the State of Illinois and the legislature of the sentiment of the I. A. C. T. toward the legislation dealing with aid for the schools, and insist that steps toward aiding schools be taken immediately.

A motion was made and seconded that the incoming president appoint a committee to notify active members of the I. A. C. T. of any vacancies in teaching positions that might occur.

An invitation for the 1935 mid-year was extended by Macomb and Cicero.

H. L. SLICHENMYER, Sec.-Treas.

A Unit Organization for Teaching High School Chemistry

By L. T. Lucas

J. Sterling Morton High School, Cicero, Illinois

The material presented in this paper is a summary of an experiment being conducted in Morton High School in Cicero in developing a unit organization that may be used in the teaching of high school chemistry. The discussion will be divided into four parts: first, introduction and definitions; second, how the units were worked out for the present experiment; third, a description of how the material is being used in this experiment as well as other ways it could be used; fourth, a brief presentation of the success as far as it may be measured at this time and the probable future of the plan.

This experiment is very new, having been started late last September. Therefore, there are practically no definite objective data to present at this time and few claims for the plan will be made until data can be collected on which to base the claims. Anything that is said of the plan will necessarily be purely subjective having been determined entirely from memory with the results of teaching during former years. In order to have objective data one must have some means of comparing the work of two different classes. In this case it would be necessary to measure the results of the unit plan by some objective method and compare those results with the results obtained in similar classes taught by the conventional method. Therein lies the dificulty of obtaining any definite results of the present experiment until it is completed. In the first place the oganization of the course in units is so much different from the conventional organization, as you will see presently, that there is little basis on which to compare the two plans as used by two different classes until the entire course is completed.

What is the purpose of breaking away from the traditional chemistry course and reorganizing it into units or into any other new type of organization? Before attempting to answer that question I prefer to ask some other significant questions. What are your objectives in teaching chemistry or do you have any clearly defined objectives that you are trying to attain during the year? Do you have any clearly defined objectives that you strive to attain each day, each week, or during the period of time that you are presenting a particular block of material? If so, how nearly are you attaining those smaller objectives or those larger objectives? If you do not have any clearly defined objectives, can you accomplish anything in teaching chemistry? I have seen various lists of objectives for teaching science in general or for teaching chemistry, but most of these objectives seem to be rather abstract in their meaning and have never been of any great help to me in teaching. Of course, I may be much different in that respect from most of you. However, during the past few years I have envolved one main objective that I am now striving to attain during the year in teaching high school chemistry. That objective is to have each student thoroughly master a few of the most important principles of chemistry so that he will be able to apply them to everyday problems now and in the future. That objective did not come to me clearly until I had studied carefully a list of the principles of chemistry that was worked out by Mr. Sites[1] and others, and to which I added a few[2].

Just a few words need to be said concerning the immediate objectives for a particular short period of time or for a particular assignment. These objectives are very similar to the main objective for the entire course. The objective for a single assignment is to strive for a mastery of a particular principle.

Is there any value in requiring a student to memorize a mass of relatively un-

related facts of chemistry which every one knows he will forget after examination day? Are any worthwhile objectives being accomplished by that procedure. In a recent study it was discovered that most modern textbooks in chemistry are considerably more than fifty percent purely factual material without any definite connection shown with any principle of chemistry[3]. The unit organization is an attempt to bring together in one unit some of the related principles of chemistry and to use the factual material merely to give an understanding of those principles. An attempt has been made to so organize the material that the student can clearly see what principle each fact is used to illustrate. The facts are then used only as a means to an end and no fact is considered an end in itself. Little attention was given to the present arrangement of material in most textbooks and it was of no concern to the author whether or not he included all the facts of chemistry, ordinarily found in textbooks, in the coures, if those facts were not necessary to a clear understanding of those principles presented in the course. Neither was any attention given to the right position of a given fact nor to whether or not that fact had been used before.

There seems to be no uniformity in the nomenclature used in connection with the unit plan of organization. Therefore, it is necessary to define certain terms in order that one may not be misunderstood in a discussion of a subject of this kind. Those definitions will be given whenever there seems to be need of them. In the first place there is very little uniformity in the use of the term unit. Billett[4] defines the unit as a "concept, attitude, appreciation, knowledge, or skill to be acquired by the pupil, which, if acquired, presumably will modify his thinking or his other behavior in a desirable way." Morrison[5] defines the unit as "a comprehensive and significant aspect of the environment, of an organized science, of an art, or of conduct, which being learned results in an adaptation in personality." My own conception of a unit in chemistry is not different from the two just quoted, but I prefer to state it in somewhat different terms. As I see a unit in chemistry, it is a group of related principles, a clear conception of which is necessary to a clear understanding of a major idea in chemistry. For example, the major idea to be mastered may be an understanding of the chemical nature of matter. The chemical and physical principle which a pupil needs to understand in order to acquire a clear conception of the major idea, are: The law of component substances, the law of constant composition, the atomic theory, the kinetic molecular theory, the electron theory, the law of combining weights, properties, and change of state. A problem as used in this instance will mean a concept which is to be acquired in mastering the unit proper. A problem may consist of one or more principles or it might take two or more problems to completely bring out one principle. The acquisition of the sub concepts in a problem will develop the main concept of the problem.

Probably we should distinguish clearly between the unit method and the unit organization. Probably there is no unit method, excepting in so far as there seems to be a rather widespread uniformity of method which accompanies the use of the unit. Probably any particular method of presenting material can be adapted to all types of organization of that material. However, the unit organization seems to lend itself more readily to supervised or directed study than do many types of organization; and many teachers using the unit organization present the material by directed study. When one speaks of the unit method, it is likely that he means either the directed study method or the unit organization.

One of the great advantages of the unit organization of chemistry is its decided flexibility. The course can be readily adapted to different types of classes and to the conditions. within the school, under which the work must be presented. The arrangement of the units themselves is flexible and may be arranged to suit the needs or opinions of the teacher.

The second part of this paper is a description of how the unit organization was worked out by the author. The first

step was to determine what should be the units of a high school chemistry course. The following list of units was finally decided upon. Unit I, the chemical nature of matter. Unit II, the nature of chemical change. Unit III, how the chemist represents chemical reactions. Unit IV, how the chemist classifies the elements. Unit V, the relation of solutions to chemical reactions. Unit VI, the nature of oxidation and reduction. Unit VII, the chemical nature of the non-metallic elements. Unit VIII, the chemical nature of the metallic elements. In addition to these eight units there are two supplementary units which may be used if time permits, but do not need to be considered an integral part of the course. Unit IX, the chemical nature of the organic compounds and Uunit X, the chemical nature of the radioactive elements. For the purpose of challenging the student each of these unit headings is stated in the form of a question, which he should be able to answer fully at the end of his study of the unit.

Each unit was divided into the necessary concepts which have been called the unit understandings. The unit understandings were restated in question form and became the headings for the problems which make up the unit. Each problem was further divided into its subconcepts, which make up the major ideas to be acquired during the study of the problem. A concise statement of all the concepts included in the problem was made and called the problem concept. The acquisition of the problem concept by the student is the major immediate objective of the teacher.

The next step was to gather the actual facts of chemistry which are to be used in illustrating the principles to be taught, and to organize those facts around the concepts and sub-concepts in each unit. This part of the material is really the teacher's outline or lesson plans, but has been called the assimilative material, because that is the material which the student is to assimilate during his study of the unit. Billet[6] calls this the unit. The assimilative material contains all the subject matter, facts, and experiment directions which are necessary for the successful teaching of the unit. It is necessary as a guide for the successful contruction of the unit. It is necessary as a guide for the successful construction of the assignment pages and for a guide in class study and discussion.

None of the material so far mentioned is ever placed in the hands of the students. The next step in organizing the course is preparing the student's material. This is the assignment pages called the guide sheets. Billett[7] has called this the unit assignment to distinguish it from the unit or teacher's material. The guide sheet consists of the activities and experiences which enable the pupil to master the unit; that is, acquire the desired concept, attitude, appreciation, knowledge, or skill. The guide sheet contains assignments in the various books which the student is to read, directions for experiments, questions, exercises, and other desirable activities which are aids to a mastery of the unit. The guide sheet should be as brief and specific as possible.

Of course a very important part of the unit organization is the construction of the tests, but that is probably best done after the material has been put into use in the classroom and while a class is actually using the material. I believe that a good test must grow rather than to be constructed. When a test is given once many flaws will probably be discovered.

To begin the discussion of my third point I wish to give a description of how the material is being presented at Morton and point out some of the handicaps that have to be contended with and how I am trying to overcome them. Perhaps this will show how the plan may be modified to meet local needs and conditions.

The class should be small enough that the teacher can give special attention to each individual as the need arises so that each pupil's work may be checked each day. I am not prepared to say what size class would give the greatest economy of time and effort and at the same time would give the best possible results. The period should be long enough to permit the student to read and

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Demonstration by the Knox Faculty*

I. Some Simple Demonstrations Illustrating a Few Principles of Physics

O. M. Jordahl, Professor of Physics

A rod of permalloy (containing nickel, iron, colbalt, and small amounts of other elements) and a small bar of magnetized cobalt-steel illustrated how much the physical properties of alloys depend on their chemical constitution and their preparatory treatment. The permalloy rod has a high magnetic permeability in weak fields, and a low retentivity; so that it becomes strongly magnetized when held parallel to the earth's magnetic field and yet loses all its magnetism when turned transverse to the earth's field. The cobalt-steel, on the other hand, can be magnetized very strongly and retains its magnetism well. A cobalt-steel magnet will "float" in space above another similar magnet due to the strength of the forces with which the like magnetic poles repel each other.

An electromagnet capable of supporting a load of more than 15 kilograms when supplied with current from a thermocouple demonstrated the fact that, although the electromotive force generated by a thermocouple is not large, the current which flows may be very large if the resistance of the current is low.

By heating a steel knitting needle in a Bunsen flame it was shown that iron loses its magnetic properties when heated and regains them when allowed to cool again. This change in the magnetic properties of iron occurs at the temperature at which the crystal structure of iron changes from the alpha to the gamma form. Similarly, when an iron wire is heated to incandescence by passing a current through it, and is then allowed to cool, the contraction of the wire on cooling is momentarily arrested at the critical temperature, as the change from gamma iron to alpha iron is accompanied by a release of heat. This release of heat as the iron cools through the critical temperature is called recalescence.

In conclusion is was shown that a wire carrying a current in a magnetic field experiences a force which is at right angles to both the direction of the current and to the direction of the magnetic field. Bringing a horseshoe magnet up to a carbon-filament, electric light bulb operated on alternating current caused the filament to vibrate violently. The direction of the force on the filament is reversed with each change in direction of the current.

II. Apparatus for Some Common Experiments

Ira E. Neifert, Professor of Chemistry

In presenting such a demonstration as I intend, I feel somewhat apologetic because the material is not new. Many times however, a special adaptation of a common experiment is found to be easier of comprehension than the original experiment. A great many different kinds of apparatus have been designed for the purpose of demonstrating relative degrees of ionization, some simple, others not. his piece of apparatus that I wish to show consists of a fifty c.c. burette which had been rendered useless for its orignal purpose by having its stopcock broken. This was heated in a blast lamp flame and sealed off close to the fifty c.c. graduation. A circular platinum electrode having been soldered to a piece of platinum wire with hard solder using borax as a flux, was sealed into the closed end of the burette tube. Another electrode of the same kind was then sealed into the end of a piece of glass tubing of length sufficient to reach to the bottom of the burette tube. This has now become the electrolytic cell. An ordinary twenty-five or thirty watt bulb is connected in series with this cell. Tenth molar solutions of the usual acids, bases and salts may be tried out by filling

* Demonstrations presented before the Illinois Association of Chemistry Teachers at Galesburg by the chemistry faculty of Knox College.

the cell with them and adjusting the sliding electrode so that the bulb just begins to glow. The distances apart may be estimated by the marks on the graduated burette. These distances will roughly classify the electrolytes. Exact values cannot be obtained due to a variety of factors.

In these times of frugality, and for many of us in normal times, schemes for saving money are attractive. The use of platinum wire by freshmen students has always seemed to me to be a waste and a needless expense. I would like to add to the numerous ideas for borax bead tests. By using glass rodding of three or four m.m. in diameter at the base for the bead, large beads may be made. By heating the glass rod in a flame, preferably a blowpipe flame (because one can control the oxidation or reduction) and dipping it into borax and reheating as many times as is necessary to make a mass of borax about one c.m. in length, one is ready to dip it into the substance to be tested. It is unnecessary to mention the need of reheating in the proper flame. After the bead has been made, it can be preserved for comparision with others by simply notching the glass with a file and breaking it off.

III. Some Simple Experiments on the Relative Activity of Metals with Air and Water

John C. Hessler, Professor of Chemistry

The first demonstration which I shall give is a very simple one, and is justified only as it calls your attention to the use that may be made of the activity of certain metals in absorbing oxygen. As a result we have several methods of giving emphasis to the percentage of oxygen present in the air. The historic experiment, which employs white (yellow) phosphorus, has the advantage, perhaps, of pedagogical simplicity; but it is attended by the ever-present risk of an accident, owing to the inflammability of the phosphorus. This risk is not only the personal hazard of the experimenter, but danger of fire in the school building, if scraps of white phosphorus are left carelessly about.

Many text books and laboratory manuals employ moist iron to combine with the oxygen of an enclosed portion of air; but we do not often think of the use that can be made of such metals as copper, lead, and tin for the same purpose. Thus, when copper in the form of turnings, or a coil of fine wire, or a thin sheet, is placed in the closed end of a test tube, so that it will not fall out when the tube is inverted in a beaker containing a little water, the (approximately) 20% contraction takes place in a few hours. The equation is, of course:

$$2Cu + O_2 + 2H_2SO_4 = 2CuSO_4 + 2H_2O$$

The excess of sulphuric acid should be allowed to run out, but need not be shaken out.

Copper wet with hydrochloric acid reacts in the same way. Most rapid, perhaps, is the action of copper wet with a "mush" of ammonium chloride and water. The dark-blue copper ammonium salt is formed.

Lead absorbs oxygen rapidly both when wet with sodium hydroxide solution and when wet with concentrated acetic acid. If the lead is in the form of a thin foil, the reaction with acetic acid and the oxygen of the air in the test tube is complete in half an hour. Tin in the "mossy" form, if wet with sodium hydroxide solution, shows the 20% contraction in an hour or two.

In the case of schools which assign chemical projects to students, the setting up of several of these experiments, with the metals named and with others, should furnish a most interesting exercise and give material for a most worthwhile report. The apparatus is simple; there are no experimental dangers; and the several results, all leading to the same conclusion, are decisive.

Another set of experiments suitable for project work has to do with the reaction of metals with water. We know that zinc dust, magnesium powder, and finely divided aluminum and iron react

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Guiding Students in Preparing for the Junior Academy Contest

R. M. Cassidy, Maine Township High School, Des Plaines, Illinois

I have never visited a class, a school, a college, or attended a meeting of educators but I came away with new ideas and help for my own work. It was not alone what I saw and heard but what was suggested that was helpful. In this brief sketch of my own work in preparing pupils to take part in the Junior Academy Contest you will find nothing original, but the critical attitude of your own minds will suggest new ways and means

Each of us has his own way of electing officers and carrying on the routine yearly work of his club. In the club of which I happen to be sponsor the officers are elected in the fall late enough for us to see their particular fitness for the various offices. Once the officers are elected they choose the staff of the paper and turn the responsibility of preparing it over to the editor and his associates. The editor posts on the bulletin board under some such heading as "Give Us Your Ideas" a list of scientific subjects that may or may not be chosen and asks all who are interested in writing on these to sign their names. He also asks them to sign for subjects of their choosing, for verses, jokes, cover-design, etc. Having chosen their subject, they go to work and later give the finished work to the editor and his staff. This group sifts, selects, and has re-written the material they wish to use. In some cases they build composite "poems" out of the verses handed in, but each serious article is written by one person and all editorials by the editor. We draw as many as we can into the writing game even though much of the work is to be discarded. We try to impress them with the idea that if one can tell something in an interesting way, he can write it in an interesting way.

For the projects, charts, and exhibits in general we must be constantly on the alert, ransack our minds, find suggestions in books, magazines, catalogues, etc., but most especially in the minds of the pupils. Many a boys in the early grades of school has been hoping and planning to develop some favorite idea and here is his opportunity.

On the bulletin board we post a paper asking for the following information: Would you like to enter the contest? What would you like to do? Have you a project already planned that you would like to do? Have you had any work in mechanical drawing, in art, in wood-working, in metallurgy? This paper is posted for ten days or two weeks, and then we study it and assign the work. Each pupil studies his assignment and hands in a list of the materials he needs chosen with the utmost economy. Then he is ready to go to work. No work is done in school-time with the exception of some wood-working and lettering of charts. Most of the work is done at home and often we do not see it until it is finished.

Some of you may say all of this is easy to do in the larger, more prosperous schools, but how are we in the small high schools going to compete with the large ones? I would reply to this by saying that each school can enter a paper as the cost is small. For exhibits I would suggest that you choose a few projects, economical in cost, simple in design, but of fine careful workmanship. The cost of the projects we plan for this year will be about ten dollars, and we are one of the fairly prosperous schools. We have not suffered as severely from the depression as many of the Ilinois schools.

In closing I would urge every high school to organize a club and keep it organized. Have all of your chemistry pupils belong and have every one help. Each one can do something and the older pupils' work is an inspiration to the younger classmen. This keeps clubs alive. Make projects that are useful and that can be used later in teaching, mentioning casually to your classes the one who made the helpful chart, model or whatever it may be. Discard absolutely all work that is slovenly, inartistic or unworkmanlike.

The Chemistry Teacher's Contribution to Modern Culture—(Cont. from p. 1)

readings of selections from the many excellent essays on this subject. The introductory discussion should be comprehensive enough to convey some conception of the numerous contributions of science to the evolution of modern civilization.

In this connection I would be inclined to stress the influence which scientific thought and scientific discovery have had upon civilized thought in general. I do not wish to be understood as belittling the contributions of science to material progress, for I realize that all culture must rest upon a material foundation. I believe, however, that the material achievements of science have already been amply popularized, and I fear that over-emphasis upon this aspect of science has led many people to believe that science is, as Pasteur once bluntly expressed it, "merely a cow to be milked."

Such an introduction as I have suggested cannot be counted upon to extend its influence over a complete course in science unless it is constantly recalled and supplemented in the everyday teaching of the course. A preliminary general disscusion of the method of scientific inquiry does not enable the average student to visualize the steps through which specific laws and theories are approached. Here again I would insist that although the knowledge of a scientific principle hay have considerable utility for the student in after life, a clear understanding of the derivation of the principle has far greater intellectual and cultural value

For this reason I am inclined to favor the historical method of approach whenever it can be employed without doing violene to logical organization of subject matter and without unduly retarding the tempo of the course. Fortunately there is much excellent historical and biographical material available to us. In many cases the original writings of chemical discoverers are completely understandable to high-school students, at least with

the benefit of a few comments and interpreparations from the instructor.

I can think of no better introduction to a discussion of the theory of ionization than the Willard Gibbs Medal address by Arrhenius, which is to be found in the Journal of the American Chemical Society, volume 34, pages 353-364 (1912). In it, Arrhenius relates how his studies of the conductivities of dilute solutions had led him to the conclusion that in such solutions acids, bases, and salts must be dissociated. His work had been done, however, with the purpose of preparing a doctorate dissertation. He knew full well that the concept of the dissociation of molecules was entirely too unorthodox to be acceptable to the professors who constituted his examining borad. He evaded the difficulty very skillful:ly, however, by speaking of active and inactive molecules rather than of dissociated and undissociated molecules. He then added that he believed the active molecules to be in the state described by Clausius. The fame of Clasius was apparently better known to Arrhenius' professors than his actual work, for this was equivalent to saying that the active, or conducting, molecules, were dissociated.

It is, of course, only fair to point out to students that the conservatism of Arrhenius' professors was not entirely unfounded. There was, in his student days, no adequate basis in current knowledge of the structure of matter to explain why dissociated sodium chloride should not behave like atomic sodium and chlorine. To say that the properties of an atom could be so radically altered by the imposition of an electrical charge necessarily seemed a rather thin explanation.

The historico-biological approach has several unique advantages. Among them is the ability to convey to the student the impression that the great figures of science are warm and living personalities. This in itself is perhaps not so important a consideration save that it tends to counteract a very common misapprehension. Discussions of the qualities of the scientific mind and of the characteristics of that mythical personage, the scientific man, I believe have tended to create in the popular mind a picture of the man of science which is as distorted as the college professor of the cartoonists or the Englishman of the American stage. Perhaps the only scientific character who approached closely the popular conception was Cavendish, and he was frankly regarded by his contemporaries as a freak.

In addition to some acquaintance with the great personalities of sicence, we are able to convey an intelligent appreciation of the actual operation of the scientific method and to dispel the false impression that scientific principles are handed down to us engraved on tablets of stone. We should, above all things, leave with our students a vivid impression of the vitality of science. They should know that chemistry in particular is a science still in the making, and that many of its great achievements are still in the future.

If we succeed in these objectives we shall probably succeed also in demonstrating to our students that scientific thought is nothing more mysterious and esoteric than "organized common sense." Science can well afford to base its plea for recognition and appreciation upon its real merits. I should very much regret seeing it become another mass religion, as it sometimes seems in danger of doing. Likewise, we should avoid falling into the error of transforming scientific heroes into plaster saints. I have a little chess handbook which contains a chapter entitled "Mistakes of the Masters." Something in the same spirit might be introduced into any course in science with very salutary effect.

Whether we like it or not the adolescent is, to some extent, a hero-worshipper. It should be a part of our contribution to his cultural development to furnish him with worthy objects of admiration and emulation. I recognize that we cannot create heroes by classroom fiat but I am also convinced that it is impossible for the student to admire and emulate that of which he is ignorant. It is my theory that adolescents often admire exploits and achievements which appear to us trivial for the very good reason that those are the only achievements which

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A Unit Organization for Chemistry

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organize one phase of the material without a break. According to Billett[8] the typical length of periods in those schools using the unit organization is 55 minutes. One should have a classroom equipped with a demonstration desk and the necessary apparatus and chemicals to perform all needed demonstrations. Better still would be a combination classroom and laboratory so that the students could work experiments whenever they are prepared to do so. There should be a library of reference books sufficient for the class; that is, there should be several volumes of each or a number of different texts, and a rather large variety of general reference books on chemistry. Space should also be provided for students' notebooks. The classroom should be used for chemistry only, so that the students could come in and work at times outside the regular class time if necessary. It would be ideal if the student could be allowed to take as much time as necessary to complete each unit. Even if he were so slow that it would take him two years to complete the course, that might be better than for him to fail because of the fact that he is slow.

As I said before these conditions are the ideal and some of them may be only idle dreams. However, most other handicaps can be overcome if one has an adequate library for use in the class.

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Some Simple Experiments on the Relative Activity of Metals with Air and Water

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when heated in steam, but we usually assume that they are indifferent to cold, liquid water. A series of experiments can be carried out in apparatus as simple as that used in the absobtion of the oxygen of the air. A small amount of the finely divided metal is put into a test tube, the tube is fillet with distilled water, and a light plug of glass wool or absorbent cotton is placed in the mouth of the test tube to prevent the powdered metal from

falling out. The test tube is inverted in a beaker containing a little distilled water. The tubes are examined at intervals, for several days, and the approximate amount of hydrogen formed is noted. The magnesium reacts rapidly: the results are apparent in a laboratory period; but the others may require days for the exolution of a little hydrogen. The powdered iron gives an especially interesting result; for a mass of ferrous hydroxide in the forms of slender, green filaments collects above the metal, while below the metal, where the air in the water has access, the product is rust. In one experiment, tried in this laboratory, powdered aluminum placed in water in a test tube, as desiribed, disappeared only after 17 days. At the same time a white mass of gelatinous aluminum hydroxide appeared in the water.

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The Chemistry Teacher's Contribution to Modern Culture

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they are capable of thoroughly understanding. With the heroes of such exploits they can indentify themselves, for in their daydreams they can readily visualize themselves as performing such exploits. While they may stand in awe of Professor Einstein, he is more a myth than a hero to them, for none of them can conceive of himself as propounding a theory of relativity.

In so far as the exigencies of the syllabus will permit, the attempt should be made to present chemistry in its true proportions in relation to other sciences and other fields of human activity. That students adopt and exaggerate any tendency to magnify a subject disproportionately was demonstrated to me some years ago when it was my duty to read several hundred contributions to the American Chemical Society prize essay contests. In those essays, arts so ancient that they antequate written history and modern discoveries which were almost purely products of other sciences were cited as achievements of chemistry.

In this connection is seems to me that

the high-school teacher has an opportunity to turn to advantage what he sometimes considers one of his liabilities. The necessity of teaching several subjects, while it prevents any great specialization in one, tends to maintain a breadth of outlook on the part of the teacher which he should be able to transmit to his students.

As a final item in the rather loosely organized miscellany I have offered you, I should like to suggest the potentialities of science as a basis for the proper utilization of leisure time. The proper approach is, I believe, through hobby interests. Such recreations have the virtue of being creative rather than passive, and also of being self-activating. In short, they make the individual recreationally independent. I realize that popular philosophy does not always consider this a virtue. Indeed, there seems to be a tendency to stress the cooperative factor in sports than the child or the retired business man who cannot play when he can find no one to play with him.

In the stimulation of hobby interests, we must avoid even more scrupulously than in our classroom work too rigid a departmentalization of subject matter. While the home chemistry set and the basement laboratory may appeal to a few students, the majority will find their interest more keenly engaged by pursuits to which chemistry is merely a contributor. It is useless to cite numerous examples, for hobbies must, of course, be fitted to the individual and his environment. It might mention in passing, however, amateur photography, in which chemistry together with physics can play a considerable part.

The essence of what I have been trying to say may be summarized in the observation that the mere facts and principles of science bear about the same relationship to the entire living, breathing reality as the telegraphed score of a football game does to the game itself. The least we should attempt for our students is to take them to see the game. Perhaps we can even help a few of them to play it.